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SOME ACCOUNT OF BRIDGES.

CROYLAND BRIDGE, LINCOLNSHIRE.

Having already given an account of Suspension Bridges*, we now proceed with a history of *Bridges* of the usual construction; comprising under that term every kind of structure intended to carry a road or canal across a river, valley, or other obstruction to its continuity.

The antiquity of Bridges must be nearly coeval with that of the human race. After providing food, dwelling-places, and clothes, one of the first wants of which society would be sensible would be that of some means of crossing the streams and brooks by which it was surrounded; and *natural* bridges, consisting of trunks of trees which had fallen across a rivulet, or masses of rock wedged in a mountain-fissure, would present models for imitation where such did not already exist.

The earliest mention of a bridge in history is of that stated by Herodotus (Book i.) to have been built by a queen Nitocris across the Euphrates at Babylon, to connect the two portions of the city lying on either shore. According to that historian, this work consisted of squared beams laid along the tops of a series of stone piers, which were built in the bed of the river, the waters having been diverted for a time from their natural channel, to admit of this being done. Some of the beams composing the road-way were removed every evening, to prevent the inhabitants of the two banks from robbing one another. We believe that modern travellers have not succeeded in tracing any vestiges of this bridge among the interesting remains of that city, and its site is therefore uncertain.

Such must have been the form of all bridges previous to the application of the *arch*. The precise period of its discovery has been much disputed. Two masses of stone, or two trees, mutually supporting each other over a chasm, by being *wedged* together, present the general principle of the arch, which must have been known from the earliest times. Nor does it appear to require great ingenuity to place three, or even four stones in a similar position to support one another, by being hewed into such a form that none could fall between those adjacent to it, without first displacing them, which their weight and mutual friction prevented them from doing. Arches of this simple form are now known to exist in the pyramids of Egypt; and it is supposed by some that such arches were used by the Babylonian builders.

But an arch, in the proper sense of the word, implies many separate stones, arranged to support one another in a *curve*, for the purpose of economizing material; and at what period, and by what people, such an arch was first used, is uncertain. The Etrurians were acquainted with it, and the great sewers of ancient Rome called the Cloacæ Maximæ, generally referred to the supposed period of the Tarquins (about 600 years B.C.), are the oldest works existing, in which the arch is found.

As the arch never appears in any existing remains of Grecian architecture, we may infer that nation to have either been unacquainted with it, or to have neglected it from some principle of taste or habit. As there must have been frequent intercourse between the Dorian colonies of Italy and their mother-country, we can hardly suppose this important invention could have been long concealed from so intellectual a people, and yet the second supposition is equally difficult of explanation. It is certain that, during the most flourishing times of the Athenian republic, there was no means of crossing the river Cephisus, except by boats, till the emperor Hadrian built a bridge over it.

The Romans, having been taught the construction of the arch by their brethren of Etruria, availed themselves of it on all occasions, and were enabled to construct bridges in

* See *Saturday Magazine*, Vol. VII., p. 210.

every part of their enormous empire, which remain to the present day to attest their power and their skill.

ROMAN BRIDGES.

THERE were eight bridges in ancient Rome, the oldest of which, called *Pons Sublicius*, is stated to have been erected by Ancus Martius, and was that alleged to have been defended against the troops of Porsenna by Horatius Cocles. This bridge was originally of timber; it was rebuilt with stone by Æmilius Lepidus, and thence received the name of *Pons Æmilianus;* it was again restored in marble by the Emperor Antoninus Pius, and it was from this bridge that the body of the infamous Heliogabalus was cast into the Tiber. Portions of its ruins are still extant near the Aventine Hill.

The *Pons Triumphalis* was that over which persons passed in their way to the Capitol, to whom an ovation had been decreed by the senate; its ruins are still visible near the palace of the Vatican.

The present *Ponte Sisto* was rebuilt by Pope Sixtus the Fourth, on the site of the *Janiculine bridge*, restored in marble by Antoninus Pius, from one still more ancient, situated in the oldest part of the city.

The *Pons Ælius* was originally built by the Emperor Hadrian, opposite the Mausoleum he intended for the place of his sepulture. It was restored by Pope Clement the Ninth, and is now called *Ponte Sant' Angelo*, the Mausoleum being the present Castel di Sant' Angelo.

The bridge now called, from the church near it, *Ponte Santa Maria*, but more commonly *Ponte rotto*, from two of its arches being fallen in, is all that remains of the old Roman *Pons Senatorius*, over which the senate went in procession to consult the Sibylline books. This bridge is near the Palatine Hill.

The *Pons Milvius* was built by Scaurus in the time of Sylla, at a short distance from the city, on the modern road to Florence. There are two historical events of interest connected with this bridge; on it Cicero caused the ambassadors of the Allobroges to be arrested, and obtained confirmation of Catiline's conspiracy by the letters found in their possession; and it was near the Milvian bridge that Constantine the Great defeated his rival Maxentius, on which occasion the former asserted he had that miraculous vision of the Cross which effected his conversion. This bridge was restored by Nicholas the Fifth, and is now called *Ponte molle.*

There are many other bridges in the neighbourhood of Rome, chiefly erected during the decline of the empire.

The celebrated bridge erected by order of the Emperor Trajan over the Danube, is only known from the descriptions of Dion Cassius and others, whose accounts of it are very various, though they all agree as to its magnitude. The historian just mentioned states, that it had *twenty* piers, and that its largest arches were 170 feet in span*, and raised 150 feet above the river. The architect was Apollodorus, the same who designed the forum and column at Rome, commemorating the victories of Trajan over the Dacians. The foundations of the piers of this bridge are still visible under the shallow waters of the Danube, about three miles from Gladova, near the frontier division of Wallachia and Bulgaria; but according to the account of modern travellers, there are not more than six or seven piers visible in the bed of the stream.

The Roman empire and its successors were also indebted to Trajan for the fine bridge over the Tagus in the province of Estramadura; the Arabians gave the name of *Alcantarat-al-seif*, or *Bridge of the Sword*, to the structure, and hence the town where it is situated derives its present name. This bridge was 670 feet long, and consisted of six semicircular arches, the largest being 101 feet in span, and of such an altitude as to raise the level road-way 200 feet above the river. The town of Alcantara being an important point in military operations, this bridge was nearly destroyed by the British during the campaign of 1809, in order to cut off the communication, and to impede the advance of the French army. In our paper on Suspension Bridges, we mentioned that a temporary rope bridge was subsequently thrown across one of the ruined arches, to allow of the passage of a detachment of our troops†.

The arch of the widest span which occurs in any Roman bridge is in that at Verona, called the Ponte del Castel Vecchio; the centre one of the three is 170 feet.

Our limits will not allow of any description of the numerous other works of this class spread over all southern and western Europe.

ROMAN AQUEDUCTS.

THE construction of those stupendous works for the conveyance of water from distant sources, to towns deficient in that necessary, so abundant over every part of the Roman empire, is commonly, though erroneously, attributed to the ignorance of that people in the simplest laws of hydrostatics‡. According to Julius Frontinus, Rome, in his time (about A.D. 70), was supplied with water from nine sources, brought from distances varying from ten to sixty miles, partly along subterranean passages, and partly on stone arcades across the valleys, according to the nature of the ground. One of these aqueducts, the Anio vetus, was carried on arches for a distance of forty-two miles. Every great city in the Roman empire was equally provided with a constant supply of water by means of similar works, and the remains of the arcades required for these purposes are among the most interesting monuments of antiquity.

The finest existing specimen of an ancient aqueduct is that portion of one called the *Pont du Gard*, three leagues north of Nismes, in the province of Languedoc. From some initials still legible on it, it is supposed to have been built by Agrippa, the friend and general of Augustus, to convey the waters of the spring of the present Eure to Nemausus, or Nismes. The lower tier of arches, of 80 feet in span, are six in number. The second tier consists of eleven, and the upper of thirty-five. The level of the top of these is about fifty yards above that of the river Gardon. Louis the Fourteenth built a bridge alongside of this tier and corresponding with it; and all travellers agree that the imperfections of the modern structure form a striking contrast to the beauty and solidity of the ancient work. The structure is ruined at each extremity, and thus disjoined from the rest of the aqueduct, the remains of which, however, are in tolerable preservation. The injury is supposed to have been committed by the Northern barbarians when they took possession of the country. But one still more formidable to the structure was perpetrated by the Duc de Rohan at the beginning of the last century, who, to facilitate the passage of his artillery during the religious persecutions in Languedoc, cut away the piers of the second range of arches for one third of their thickness, and three yards in height. Nothing but the solidity of the structure could have saved it from subsequent destruction; as it was, it suffered considerable settlements.

Aqueducts, in the proper sense of the word, have been constructed in modern times, and we now carry canals over valleys by means of arcades similar to those of ancient Roman work. When such a structure is employed for a road-way or rail-road it is called a *viaduct*,—an useless term,—for to all intents and purposes it is a bridge.

Our readers will be better able to appreciate the merits of such works, if we briefly explain in what the difficulty of constructing arches consists. If an arch had no superstructure to support, there are certain curves in which the wedge-shaped voussoirs might be arranged so as to ensure perfect stability, or so that no portion of the surfaces of these stones which are in contact, shall be pressed more

* There are several terms employed in describing arches and bridges, with which the reader should be acquainted.

The *span* or *chord* of an arch, is the *horizontal* distance between the piers or abutments which support it, *measured at the points where the arch begins or springs.* A straight line being supposed drawn at those points.

The *versed sine* is the height from this line or chord, to the highest point of the underside, or *soffite*, of the arch. This term, though properly applied to the circle only, will be used in this paper even when speaking of elliptic and other curves.

The *arch-stones*, or *voussoirs*, are the separate pieces of which the arch is composed; they are usually odd in number, the centre one being called the *key-stone*, which is at the highest part of the curve. Of the two curves formed by the lower and upper faces of the voussoirs, the former, or real outline of the arch, is called the *intrado*, the other the *extrado.*

The *spandril* is the space comprised between the upright line of the pier, the road-way, and the curve of the extrado. Each arch, therefore, has two spandrils, which are usually equal and similar.

† There is a view of the bridge with this addition, in the frontispiece to Sir H. Douglas's work on military bridges.

‡ When labour was cheap, because it could be commanded to an unlimited extent, in consequence of the existence of slavery, it was perhaps considered an easier and shorter method of effecting the object, to build a ponderous aqueduct of stone arches, than to form and unite short pipes of metal or earthenware for an equal distance We know that the Romans could make such pipes, but possibly not of any great length, or of sufficiently good workmanship to resist the pressure of a current of water descending from a considerable elevation.

than another, and therefore there would be no tendency to give way in one part more than another. A dome, to cover over a building, may be built of small stones or bricks, which would be perfectly secure, of whatever magnitude it might be, provided the materials were sound, and properly put together*. But arches are generally intended to support some superstructure, and on account of the curvature of the arch, there must be a greater depth of materials over the spandrils than over the *crown*, or highest part; and consequently, a greater weight pressing on the haunches of the arch.

This causes the necessity for varying the size of the voussoirs, so that those which form the lower part of the arch may be enabled to resist this additional weight; and the whole must be constructed with reference to the inequality of pressure exerted among the arch-stones, in consequence of this change in the conditions of the problem.

To construct an arch with any other curve than the circle, considerably increases the practical difficulty, both in framing the *centering* of timber to support the arch-stones while they are being put up, and because in this case it is necessary to give each of these a different form of outline, so that when put together, the intrado may be of the proper curve. Hence builders, in all times, rejecting these complicated curves, have almost always adopted the *circle;* and in order to obviate the sources of weakness arising from the theoretical deficiency, they have made the voussoirs large enough to ensure stability; that is, they have made them deep enough in every part of the arch to include the proper curve of equal pressure between the intrado and extrado.

It however now became a point of importance to ascertain the minimum of size of the voussoirs compatible with the stability of a circular arch,—this is the point on which the architect must show his science, so that there may be no useless waste of material. One mode of obtaining increased stability would obviously be to load the vertex, or crown, of the arch, so as to counterbalance the weight of the spandrils on the haunches, which has always a tendency to force up the voussoirs at that part. But this remedy would preclude the possibility of making the road-way of a bridge straight, and would give an inelegant clumsiness to the outline of the structure. The next resource consists in lightening the weight on the haunches, by leaving arched cavities in the spandrils, and this is what is usually done in modern bridges; the same end combined with a more elegant outline of intrado, is obtained by adopting elliptic arches, as was done with the Waterloo and new London bridges.

The first important epoch in the history of bridge building, which occurred after the overthrow of the Roman empire, was the establishment of the religious society called the "Brethren of the Bridge," the object of which was to secure travellers from the dangers arising from the anarchy which reigned over Western Europe after the decline of the second, and previous to the establishment of the third, or *Capetian*, race of French monarchs. The mode adopted for effecting their benevolent purpose by the members of this admirable institution, was to keep up and improve the principal roads, and to build bridges where they crossed rivers. We refer our readers to Vol. VI. p. 110, for an account of the bridge at Avignon, built under the auspices of this institution.

The "Brethren of the Bridge" erected a bridge at Lyons of 20 arches, and another also over the Rhone of 19 arches, besides several smaller in the abutments. Both these works are remarkable for not being in a straight line on their plans, but curved so as to present a convex front to the current of the river; they still exist.

* An interesting anecdote relating to this subject, is mentioned in the *Encyclopædia Metropolitana*, article, "Bridge." A gentleman wishing to cover over a chamber, intended for chemical processes, with a brick arch, drew an outline of the proper curve (*a catenary*), by suspending a chain of the requisite length against a smooth upright surface, and by marking on this in chalk the exact curve in which the chain hung; the *centering* for the arch being made according to this model, the arch was built, and found to be perfectly secure in every part. Soon after, requiring another vault precisely like the first, he left orders with the workmen to adopt the same precautions in every respect; but during his absence, the men, conceiting that the gentleman was "over particular," and that a circle would "do just as well," made the new centering accordingly, and built the arch on it; the gentleman returned to see the centering struck, and when that was done, down fell the arch,—a valuable comment on the popular prejudice in favour of *practical* over *theoretical* knowledge, as it is termed, "a bricklayer must know how to build an arch better than a gentleman."

It may be easily imagined that those architects and workmen who for so many centuries could design and execute the magnificent Gothic cathedrals which embellish Europe, must have been perfect masters of every resource in the practical part of their arts, and were capable of erecting stone arches of the largest span. The bridge over the Allier, at Brioude, in Auvergne, and called *Vieille Brioude*, was built in 1454, by Grenier and Estone; its principal arch is 183 feet in span, and 70 feet in height, the voussoir at the crown being only 5 feet 3 inches deep†.

There is another at Claix, over the Drac at Grenoble, of 150 feet in span; and a bridge built at Verona, in 1354, has an arch of 160 feet.

The Arabians, who, in every part of the extensive empire they founded in the sixth, seventh, and subsequent centuries, led the way in cultivating literature and science, by studying the works of the Greeks and Romans, were not backward in the erection of new bridges in their Spanish dominions, to facilitate mutual intercourse between the different provinces; and rivalled the Roman structures of the same description in the magnitude and solidity of their own. A view and account of one of the finest, that at Cordova, built by Hescham, son of Abdalrahman, in the beginning of the ninth century of our era, will be found in the *Saturday Magazine*, Vol. VI. p. 235.

One of the most noted bridges in Europe, from its being mentioned in several poetic works of the highest order‡, is the Rialto at Venice, built by Antonio da Ponte, in 1591, after a design of Michael Angelo as it is said. The arch is only 89 feet in span, the versed sine being 20½; with so large a segment, the roadway is necessarily very steep up each side, and is formed into a flight of marble steps; there are two rows of shops on it, dividing the road into three narrow streets, which communicate with one another by an archway at the centre, running across the width of the bridge, which is 66 feet. The whole structure resembles less a bridge than an architectural composition supported by an arch, and we think that, if divested of its associations, it would not excite much admiration in any respect. From the nature of the site, it required an extended foundation, which rests on about 12,000 piles of elm, the expense of the whole amounted to 250,000 ducats.

Venice possesses altogether no less than 340 bridges over its canals.

THE BRIDGES OF GREAT BRITAIN.

As might be supposed, our own country yields to none in the world, as regards the number, magnitude, beauty, and variety of our bridges; and though we cannot boast of possessing any Roman work of this kind, yet we have one more ancient than any in Europe, not erected by that people, and which is unrivalled for its singular construction; we mean that at Croyland, in Lincolnshire. This is supposed to have been built about the year 860; it consists of three semi-pointed arches, meeting together in the centre, the abutments standing on the angles of an equilateral triangle. It is placed at the junction of three roads, which thus terminate at the crown of the bridge. The steep ascents are made into steps, paved with small stones set edgewise; at the foot of one segment there is the ruined statue of some Saxon monarch, by some supposed to be Ethelbert.

The Bridge at Burton-on-Trent was built in the twelfth century by Bernard, abbot of that place. It is the longest bridge in England, being 1545 feet from one extremity to the other, and consisting of 34 arches.

A brief notice of the London Bridges has appeared in the first volume of the *Saturday Magazine;* but the interest of the subject to every inhabitant of the metropolis, will warrant us in entering into a more detailed account, and we shall bestow the greater part of our space on *old London Bridge*, a structure peculiarly endeared to all antiquarians and historians of our city, and the destruction of which they must deplore while they admit its necessity.

The first Bridge over the Thames was one of wood, erected in the year 993, opposite the site of the present St. Botolph's wharf. A statute of King Ethelred the Second,

† It is nearly equalled by one in a bridge over the Danube, built by Wicbeking, in 1806. This arch is 181 feet, and only 22 feet 3 inches versed sine; the voussoirs at the crown being 6 feet deep; and both are surpassed by that over the Dee at Chester, erected within these few years.

‡ By Shakspeare, in the *Merchant of Venice*, by Otway in *Venice Preserved*, and by Lord Byron in *Childe Harold*, besides many others.

fixing the tolls to be paid by boats bringing fish to "Bylyngsgate," alludes to this bridge; and the fleet of Sweyn, King of Denmark, in an invasion he made on this country, was injured and impeded in its progress up the river by running foul of it.

The origin of this bridge is curious, and deserves to be noticed. There had been a ferry at the spot, the proprietor of which left it* to an only daughter, named Mary, who, being in good circumstances, founded a *house of sisters*, or convent, near the church of St. Mary Overie, in Southwark, the present St. Saviour's, and endowed it with the ferry and its proceeds. This convent was afterwards converted into a college of priests, who built this wooden bridge, and maintained it in repair, till finding that the expense would be ultimately saved by a greater immediate outlay, agreed with the citizens of London, who were chiefly benefited by it, to substitute one of stone.

The wooden bridge had been exposed to many vicissitudes; it was nearly destroyed soon after its erection by the Norwegian Prince, Olaf, who attacked the city in behalf of his ally, King Ethelred, whom the citizens had refused to acknowledge. In 1016, Canute, being prevented by the bridge from sailing up the river, dug a channel at the southern end and carried his fleet through it to the western side of the bridge. In November, 1091, the greater part of the bridge was carried away by a violent flood; it was then repaired by a tax levied on the city by William the Second. In 1136 it was again damaged by a fire, and though again restored, in 1163 it was found to be in so dilapidated a condition as to require to be nearly entirely rebuilt, which it was under the direction of PETER OF COLECHURCH†, a priest and chaplain. When the college resolved to erect a stone bridge, attention was turned to Peter, as the person best qualified for conducting the work, and, as it proved, he amply justified the choice; for so sound was the edifice he raised, that it endured for 600 years, trials which would have destroyed most others.

The *new* bridge was begun about 1176, a little to the west of the old wooden one. So strongly was the necessity for such a work felt, that contributions to it flowed from all parts; the king gave the proceeds of a tax on wool‡, the pope's legate, the Cardinal di Petraleone, gave 1000 marks towards the expense, and the Archbishop of Canterbury, and multitudes of other persons, contributed according to their means.

The piers were built on a framework of elm piles, driven in as close as they could stand, with oak-sleepers laid on the tops, and the intervals filled in with rubble. The coffre-dams, which were made round each, were never removed, and constituted the sterlings, which formed so singular a feature in this venerable structure. The lower courses of the masonry, exposed to the action of the water, were laid in pitch instead of mortar, for at that time no cement of lime was known, which was capable of *setting* under, and resisting the action of water.

In 1205 Peter died§, and three merchants of London were appointed to complete the work, which they did in four years more. The bridge when finished contained 20 arches, of the pointed Gothic form, of unequal magnitude; the total length was 915 feet, and its width 73 feet.

The master-mason of the work, whose name has not been recorded, erected a chapel, at his own cost, on the east side of the ninth pier from the northern end of the bridge. This chapel, which was dedicated to St. Thomas, was remarkable in many respects; it was a Gothic structure of great elegance of design; the lower story was a crypt, and stood on the sterling of the pier, which was carried out for the purpose 50 feet further than any of the others; the upper part, or chapel, was level with the roadway of the bridge, and stood partly on the pier, presenting a front to the road 40 feet high and 30 wide; the length of the whole building was 60 feet. The body of Peter of Colechurch was deposited in a stone tomb in the crypt of this chapel, within the pier of the bridge; a proper burial-place for the architect. This chapel was, at successive times, augmented by several chantries, so that in the time of Henry the Sixth there were four chaplains belonging to it, whose stipends were bequeathed by different persons at their death. It afterwards became the property of St. Katherine's Hospital, and though it was suppressed as a monastic institution at the Reformation, yet divine service was performed in it till the beginning of the last century; it was then occupied as a shop, and the crypt converted into a paper-warehouse; and such was the solidity of the work, that, though the floor of this story was nearly 10 feet below high-water mark, yet no damp penenetrated the walls. In the enclosure of the sterling, in front of the end of the edifice, a fish-preserve had been made, into which the tide carried the fish, and they were secured by a wire grating; a winding staircase led down to this pond from the chapel. A person who had all his life been connected with the Bridge-House Estate, was living within the last few years, who well remembered descending by this access to fish in the preserve.

This interesting chapel was pulled down in 1760, on the occasion of the repairs and improvements being made to the bridge, and the workmen had some difficulty in detaching the stone-work and iron cramps with which it had been put together: an antique marble font, and some ancient coins were found. The tomb in the crypt was enclosed in the portion situated within the pier by the new facing erected at that time.

The arches of the bridge were of different widths, as most of our readers will still remember; four of the widest, which admitted the passage of larger boats, were called *locks*, and there was a moveable *draw-bridge* instead of a stone arch, between the sixth and seventh piers, to admit of still larger vessels coming up the river; this draw-bridge is frequently alluded to in the histories of those times.

There was a tower erected at each end of the bridge at the time of its completion, a practice general with such structures in those periods, when, of course, a bridge would be the first point of attack by a foe approaching the city to which it furnished access. In 1426 a third was built at the north side of the draw-bridge just alluded to; but that various other dwellings were erected on the bridge immediately after its completion, is proved by the mention of the destruction of 3000 persons three years afterwards, who were on the bridge when a fire, which had begun at the Southwark end, communicated to some buildings at the other extremity; these unfortunate people, neglecting to retreat in time, and thus enclosed, were either drowned in endeavouring to escape by the river, crushed in the struggle, and by falling ruins, or miserably burnt in the flames.

These houses were soon generally spread over the whole bridge, and a curious view of the structure, executed by one Norden, in the time of queen Elizabeth, but not published till that of her successor, has the following passage in an eulogy appended to it.

"This famous bridge is adorned with sumptuous buildings and statelie and beautifull houses on either syde, inhabited by wealthy citizens, and furnished with all manner of trades, comparable in itself to a little city, whose buildyngs are so arteficially contryved, and so firmly combined, as it seemeth more than an ordinary street, for it is as one continuous vaute, or rooff, except certain voyd places reserved from buildings for the retyre of passengers from the danger of cars, carts, and droves of cattle, usually passing that way. The vaults, cellars, and places in the bowels, as it were, of the same bridge are many and admirable, which arte cannot discover to the outwarde view." (that is, could not be shown in the picture.)

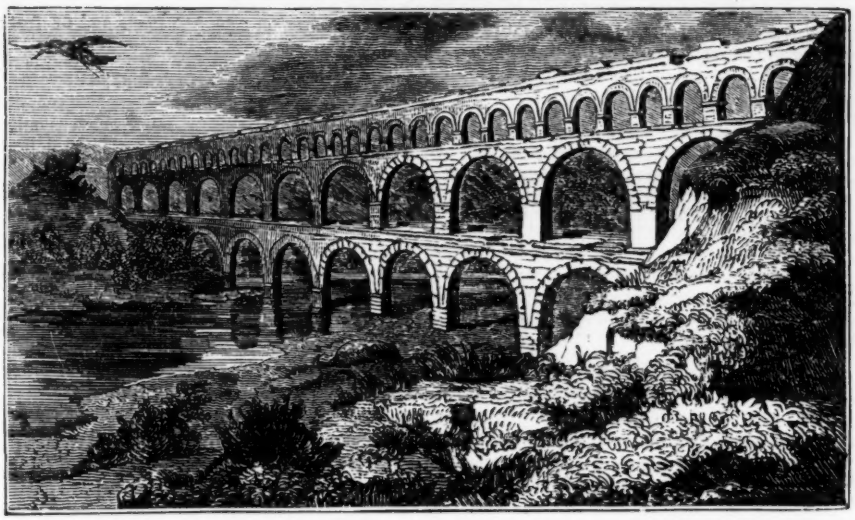
These "voyd places" seem to have been especially necessary, for when it is mentioned that the street left between the houses on each side was only twenty feet wide in its widest part, and had no footway, it may be supposed the transit of the bridge, to pedestrians, was not a little hazardous; indeed it is stated by some chronicler, that their

* There is an antique monumental figure in St. Saviour's Church, Southwark, which is traditionally said to be that of this ferryman.—See J. T. SMITH's *Antiquities of London*.

† St. Mary Colechurch was a small church built by a citizen named Cole; it was situated at the corner of the present Grocer's-alley, in the Poultry. After the destruction of it by the Great Fire in 1666, the parish was annexed to that of St. Mildred. Misled by the name, some antiquaries have supposed that Peter was of Colchester, but it appears most probable that he was a native of London.

‡ Hence arose the popular belief and saying, that the foundations of Old London Bridge were laid on wool-packs.

§ The similarity in the history of this work and its architect, to that of the Avignon Bridge, built at the same time by Benezet, will strike our readers; each obviously was a man of superior talents, in every way capable of attracting the confidence and esteem of their fellow-citizens, and honoured accordingly at their deaths; only that our countryman was not canonized, and miracles were not attributed to his remains, because the English ever have been a sober people. We could have wished that they had shown a little more *feeling* lately on the subject. When the Old London Bridge was pulled down, the stone-coffin of Peter was broken open by the workmen, and not containing any treasures, was thrown into the Thames; this was not unnatural in persons of that class, but we think more care should have been taken by the principals to obviate such an occurrence, or at least to recover the relic, and deposit it in some fane, as Westminster Abbey, along with the remains of other men of genius and benefactors to their race.



REMAINS OF A ROMAN AQUEDUCT, NEAR NISMES, CALLED THE PONT DU GARD.

only security was to follow in the wake of a cart or a horseman. It was only through these cross vacancies between the houses, that the river could be seen from the bridge, there were parapet walls or palings left at each end of these places for this purpose. The first on the bridge, from the city end, was dignified with the name of London Square.

A fire, in 1646, having destroyed a large mass of these buildings at the north end, the space was filled up again with "New houses, three stories high, besides the cellars which were within and between the piers: and over the houses were statelie platforms leaded, with rails and balusters, and some had pretty little gardens with arbors."

Nonsuch house, a curious building of the Elizabethan age, entirely of timber prepared in Holland, and put up on the bridge, stood near the draw-bridge over the seventh arch, and overhung the river on each side; it was four stories in height, richly carved and gilt. The whole framework was put together with wooden pegs only, no iron being used in the construction.

This labyrinth of dwellings was almost entirely destroyed by the fire of 1666, and the ruins, with what remained, having been cleared away, and the bridge itself repaired at an expense of fifteen hundred pounds, the whole street was re-erected within twenty years on a more regular plan*, yet, though improved, the passage was still inevitably narrow, dark, and dangerous. Harrison, in his history of London, describes the appearance of the bridge, about 1750, in the following terms:—"Across the middle of the street were several lofty arches extending from one side to the other, the bottom part of each terminating at the first story, and the upper part reaching to near the tops of the buildings; these arches were designed to support the houses on each side of the street, and were therefore formed of strong timbers bolted into the houses, which being covered with lath and plaster, appeared as if built of stone. On the outer part of the bridge, on the east side, the view from the water and the quays was sufficiently disagreeable; nineteen disproportioned arches and sterlings, increased to an amazing size by frequent repairs, supported the structure above; these arches were of very different sizes, several that were low and narrow were placed between others that were broad and lofty. The back part of the houses next the Thames had neither uniformity nor beauty, the line being broken by a great number of closets that projected from the buildings, and hung over the sterlings. This deformity was greatly increased by the houses extending a considerable distance over the sides of the bridge, some projecting further over it than the others, by which means, the tops of almost all the arches, except of those that were nearest, were concealed from the view of the passengers on the quays, and made it appear like a multitude of rude piers, with only an arch or two at the end, and the rest consisting of beams extending from the tops of the flat piers, without any other arches, quite across the river."

* The site was let on building-leases, for 61 years, at a rent of ten shillings per foot frontage, a proof of the high estimation the situation was held in by tradesmen, on account of the publicity of such a thoroughfare.

As early as the time of queen Elizabeth, mills for grinding corn had been erected under the arches at the Southwark end. In 1582, Peter Morice, a Dutchman, erected the water-works at the north end of the bridge; having obtained a lease of the use of the water, and one arch, with the sterlings, on which to erect his machine, for five hundred years, at the rent of ten shillings; the great benefit of these works having been felt, the citizens, in succession, granted him and his successors similar leases of three more arches. Morice made a large fortune, and the property, which continued in his family till 1701, was then sold to one Soames, a goldsmith of the city, for 36,000*l.*

At last, in the year 1755, the incovenience of the houses and the narrow street they left, being more felt from the increasing population of London, they were all cleared away, the bridge restored, parapets and balustrades erected on each side, and two of the middle arches thrown into one, to enlarge the water-way, and an archway opened through the tower of St. Magnus' Church, for the accommodation of the foot-passengers. In this state this venerable structure remained till its final demolition, in the year 1833†.

To allow of these extensive changes and repairs, it was necessary to construct a temporary wooden bridge on the sterlings, for the accommodation of passengers. This structure was burnt down on the night of April the 10th, 1758; and from evidence given at an inquiry into the event, there was great reason to believe it to have been the work of incendiaries, but though a reward of 200*l.* was offered for their apprehension, no discovery of them ever took place. A new bridge, of a similar construction, was immediately commenced, and completed within a month.

A new bridge, to form a communication between the city of London and the opposite shore, being imperatively required by the rapid increase of the former, an act of parliament was obtained, in 1736, for the erection of one at WESTMINSTER; and M. Labelye, a Swiss Architect, was selected to execute the work. The first stone was laid by the Earl of Pembroke, in January, 1738—9, and the bridge was opened on November 17th, 1750.

The erection of this bridge formed an epoch in the arts, from *caissons* being, for the first time, employed in building the piers. It had always been the custom, in the construction of modern bridges, to form a *coffre-dam*, or enclosure of strong piles driven into the bed of the river, large enough to allow of the pier being built within it; this work was

† It would have been naturally expected that the river on each side of the bridge would be the receptacle of numberless articles thrown from the houses which, for so many centuries, had existed on it. Accordingly, during the excavations for the piers of the new bridge, the following curious and valuable relics were obtained,—

Roman Coins in brass and silver, of most of the emperors, from Augustus down to Constantine: a statue of a horse, of beautiful workmanship, a bronze statue of Harpocrates, and antique lamps. *Saxon, Danish, Norman Coins* from Ethelred and Canute down to the time of William and Mary, a large quantity of them in gold; also gold seals, crucifixes, brooches, rings, daggers, swords, watches, spoons, and plate, keys, and a leaden seal, with P.P. Urbanus VI. and a reverse of the heads of Peter and Paul, which had been appended to a bull, and many other articles besides, in pottery.

made water-tight, by clay, &c. rammed between two rows of piles, and the water being then pumped out, the foundation could be dug and prepared, and the masonry built without impediment from the river.

The method pursued in the erection of Westminster-bridge, was briefly as follows. The mud having been removed by dredging, till the firm sand was reached, the surface of this was laid level by raking, and tried by repeated measurements with a proper instrument. The *caisson* consisted of an enormous *chest*, formed of timber-beams, the bottom being made capable of separation from the sides, and the whole rendered water-tight while it was in use. This chest being floated to the proper spot over the prepared foundation, it was secured to fender-piles driven round the place; and the lowermost course of masonry being laid in it and cramped, the water was admitted into the caisson, by a sluice-gate, and sunk it. It was then ascertained whether it lay truly level on the bed of sand; the sides of the caisson were made sufficiently deep to allow of its edge being above the level of the water when it was sunk, so that by shutting the sluice, and pumping the water out, it would float again with the masonry in it.

If any defect in the level had been discovered, the bed was corrected accordingly, and new courses of masonry being built on that already laid, the whole was again sunk into the precise spot. By these means the pier was raised nearly to the level of low-water, so that by availing themselves of the ebb, and pumping out the water, the workmen could soon add additional courses of masonry, and raise the work above the level of the high tide. When this was done, the sides of the caisson were detached from the bottom, and floated ashore, to be fixed to a new one, to serve for another pier.

The bridge is 1223 feet long, and 44 wide, between the parapets; there are thirteen semicircular arches, besides a smaller one of 20 feet, at each end, next the abutments; the centre arch is 76 feet span, the others decrease in width regularly, both ways, by four feet each. The piers and arches are of Portland stone, the spandrils or haunches being filled up with courses of Purbeck-stone, laid so as to form an arch, so adjusted that the whole mass shall be in equilibrium; each arch is consequently independent of the adjoining ones for support.

The piers between the arches form semi-octagonal projections, which terminate at the parapets in recesses, in which are benches for the convenience of passengers. Six of these, on each side of the bridge, are arched over with stone, forming sheltered alcoves.

The bridge was not quite completed, when one of the piers sunk considerably, in consequence of a quantity of sand for the roadway having been dredged for too near the foundation, and some feet below it. It was necessary to take down the two adjoining arches, and the pier being loaded with cannon till all subsidence ceased, it was raised up to a level with the others, and the arches rebuilt.

The total expense of Westminster Bridge amounted to about 390,000*l.* Its merits, though of a substantial kind that must always excite admiration, were soon eclipsed in outward show by a rival structure, that of BLACKFRIARS.

This bridge was begun in October, 1760, and opened in 1771. The architect was Mr. Robert Milne, a Scot, who while he profited by the able example in scientific construction set him by Labelye, surpassed it far in boldness and elegance of design. Unfortunately this new structure was built of such perishable stone, that it already is greatly decayed, and requires frequent repairs.

The total length of the bridge is 995 feet, the width between the parapets 42; it consists of nine semi-elliptical arches, the central one being 100 feet in span, and the smallest 70. The piers have rounded ends to some height above high-water, above this there are two Ionic columns standing out isolated from the face of the structure with corresponding pilasters behind, supporting an entablature and projection on the parapet above, which forms a recess with benches. These columns constitute the most objectionable part of the design, in an architectural point of view; for the line of the parapet being a curve, the columns are necessarily of different heights and diameters.

WATERLOO BRIDGE is generally admitted to be the finest in England, if not in the world; though its arches are far surpassed in span by some built subsequently to it, yet no other bridge unites such simplicity and grandeur of design with such magnitude. It was designed and executed by the late Mr. Rennie, commenced in 1811, and opened on the 18th of June, 1817. It consists of nine equal, semi-elliptic arches, of 120 feet span, and 32 feet versed sine. The piers are ornamented with two Grecian-Doric columns, supporting a plain entablature; and the line of the parapet being perfectly level, these columns are all equal*.

Numerous and beautiful as are the stone bridges, over every part of this kingdom, our space will only allow of our noticing one more. The remarkable bridge at Pontypryd, over the Taaf, near Llantrissent, in Glamorganshire, was built, in 1746, by William Edwards, a self-educated country mason. He had engaged to erect a bridge, and accomplished his task in a superior manner, but there were two piers to the structure, and a great flood carried it away two years afterwards. As Edwards had contracted to *uphold* the work for a certain term, he was obliged to rebuild it, and, to avoid a recurrence of the same accident, he determined to make it of one arch of 140 feet span. He had no sooner completed this bold undertaking, than the weight of the haunches forced up the crown, and his beautiful arch fell to the ground. Undaunted by these misfortunes, this enterprising man recommenced his work a third time, and consulting with Smeaton, he resolved to rebuild the arch of the same span and height as before, but to equalize the weight, he built the spandrils with three open circular arches through them, of nine, six, and three feet diameter each: this plan succeeded, and his bridge stands to this day, elegant as a work of art, but doubly interesting as a memorial of patience, industry, and talent.

BRIDGES OF FRANCE.

NEXT to our own metropolis, Paris is the city most interesting to us, from the constant intercourse, whether pacific or hostile, we have ever had with the French nation. The narrowness of the Seine at Paris, precludes the necessity for such magnificent bridges as those which adorn London; but in taste of design, and skill in execution, the French architects are quite equal to our own.

On account of the two islands in the heart of the city, Paris requires no fewer than sixteen bridges to facilitate the communication between the opposite banks. We shall in this place notice only those of stone, and our limits oblige us to be brief in our descriptions.

The *Pont au Change* unites the Isle du Palais with the northern portion of the city, and a bridge has existed at this spot from the remotest antiquity. The present name is derived from the quarter having formerly been the abode of the money-brokers, but it was anciently called *Grand-pont.* The old bridge was destroyed along with two others, by a sudden flood, in 1408, a fate which it again experienced in 1616, after being restored.

This bridge, like our own old London, and so many others in similar situations, was encumbered with dwellings on it, and on the occasion just alluded to, some of the furniture and moveables were carried by the river as far as St. Denis. The structure was rebuilt of wood, and in 1621 it was again destroyed by fire;—the present stone bridge was in consequence erected in 1639-47. But the houses, which were also restored, were finally removed in 1788, by order of the monarch. The centre arch of this bridge is the greatest span of any in Paris, being 100 feet, a fact which serves as a scale of comparison between those of that city and of London.

The *Pont Neuf* is situated at the western extremity of the Isle du Palais, and is divided into two portions, which unite the intervening island with the two banks The Pont Neuf was commenced during the reign of Henry the Third, in 1578, from designs by *Androuet du Cerceau;* but in consequence of the civil commotions which distracted France for so long a period, it was not completed till 1604, by *Charles Marchand,* in the reign of Henry the Fourth. It is on the esplanade in the middle of the bridge formed by the extremity of the island, that the celebrated equestrian statue of that monarch is situated, which forms so conspicuous an object in one of the finest city views in the world. The southern portion of the Pont Neuf consists of five, the other of seven semicircular arches of such simplicity and strength as to give the edifice the character of an old Roman work. Its total length is 767 feet.

The *Pont Royal* was erected by Louis the Fourteenth, in place of an older wooden bridge destroyed by a flood in 1684.

* For a notice of the New London Bridge, with a view of it during its erection, see *Saturday Magazine,* Vol. I., p. 81. We have entered into a few more particulars of the other Metroplitan bridges, for reasons before given. In the account just referred to, the number of arches of Westminster-bridge are erroneously stated to be fourteen, instead of fifteen

It is a handsome bridge of five arches, the centre one of 82 feet span. It is situated opposite the Palace of the Tuileries; the architect was Julius Hardouin Mansard, who first contrived the attic in the roof, which bears his name.

The name of the *Pont Louis Seize*, indicates its founder, and derives some interest from its having been completed with stone from the Bastille. It is situated in the finest part of the city, opposite the *Chambre des Députés*, and the *Place Louis Quinze*. This bridge is the work of the celebrated Perronnet, who may be regarded as the French Rennie. It consists of five flat semi-elliptic arches, a favourite form with that architect, and characterizing many of his bridges. The Pont Louis Seize is adorned with colossal statues of celebrated historical persons, and altogether is a striking object.

The last Parisian *stone* bridge we can notice, is the *Pont de l'Ecole Militaire*,—perhaps, in an architectural view, the finest of them all. Like the last, its five arches are flat ellipses of 82 feet span each, and the road-way is level. It is from the design of Lamande, and was built in 1806-13.

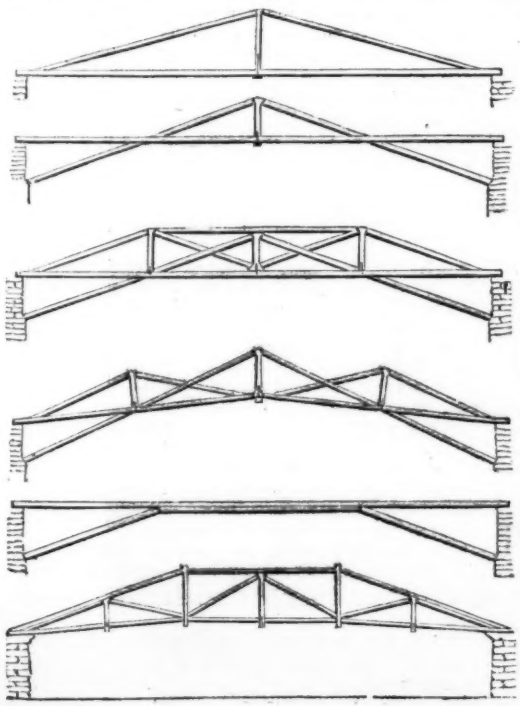
Perronnet has embellished other towns with bridges of stone of great beauty; among which, that at Neuilly, consisting of five equal arches of 128 feet span, with a versed sine of 32; and that over the Oire at Maxence, remarkable for its light and novel piers, formed of four doric columns, the central intercolumniation being left open, are the most celebrated.

TIMBER BRIDGES

Must, for reasons before alluded to, have preceded the construction of those of masonry; and when the limits of the arch, as they were conceived, up to a comparatively recent period, were attained, recourse was had to timber for bridges, in those situations where stone ones could not be erected.

The advantage of timber consists in its lightness, and the great length in which it can be obtained in one piece; consequently, any structure composed of it, can be more rapidly put together than if masonry were the material; and fewer and lighter piers and abutments are also required. But a beam of timber of considerable length is incapable of bearing any great weight or strain, applied between its supported ends, and acting at right angles to its length. To remedy this weakness, recourse is had to *trussing*, or *framing*, a simple and beautiful application of mechanical principles, by which the strain, or weight, of a timber structure is in a great measure made to act *lengthwise* instead of *across* each beam composing it.

The annexed figures will explain in what various manners timber beams may be trussed, or framed, so as to span a considerable width. The lowest is the outline of a timber



bridge, of 114 feet span, constructed over the Cismone, between Trente and Bassano, by the celebrated architect Palladio.

Every schoolboy knows Julius Cæsar's account of the wooden bridge he threw over the Rhine. This is the earliest notice we possess of such a work; and if that warrior's military skill had not been greater than his mechanical, his fame would scarcely have survived his structure, which, even for a first attempt, was clumsy and unscientific in the extreme.

Far otherwise was the celebrated timber bridge erected in 1758, at Schaffhausen over the Rhine, by a self-taught genius,—a common carpenter of the name of Ulric Grubenman. The rapid current of the river having gradually undermined the piers of a stone bridge at that place, it fell down in 1754, and it was resolved to supply its place by one of timber, as requiring fewer piers, and therefore not being liable to the same source of destruction. Grubenman offered a model of a bridge requiring no pier at all, but his design being considered too daring, the authorities insisted on one pier of the old bridge, which was intentionally left standing, being used as an intermediate support. The artist accordingly modified his design, and the bridge was built, apparently, in one span from shore to shore, but additional strength was given by beams springing from the pier in question. The length of the bridge was 364 feet, its breadth 18 feet. It was not in a straight line on the plan, but formed a very obtuse angle towards the current*. The bridge was an enclosed gallery,—the sides consisting of the framing of the complicated trusses necessary to support such an arch, and there was a roof over the road-way resting on these sides. This beautiful and wonderful work was entirely destroyed by the French, in their campaign of 1799.

Ulric had a brother John, no way inferior to himself in mechanical talent. This man, about the same time, erected a wooden bridge on the same principle, at Ruichenau, 240 feet in length; and the two brothers united their talents to build similar structures in various parts of Germany.

Wiebeking, another German workman, has erected numerous beautiful timber bridges in his native country since the commencement of the present century. He designed one of 610 feet span, with a versed sine of only 26 feet, the timber framing at the vertex to be only 4 feet deep.

In America, where timber is superabundant, that material is frequently used for constructing bridges on the largest scale. The earliest was erected by Palmer over the Piscatagua, near Portsmouth, in 1794, of 250 feet span. There is another at Trenton, over the Delaware, built by Burr, in 1804, of 200 feet span, and 32 feet rise, the depth of framing being only 2 feet 8 inches at the vertex.

But that at Philadelphia, over the Schuylkil justly deserves the name given to it of the *Colossus*, as exceeding all others in its span, which is no less than 340 feet, with a rise of only 26 feet, and a depth of 7 feet in the vertex. This stupendous arch was constructed by Wernwag, in 1813; it consists of three equal and similar ribs, each composed of seven thicknesses of planks, 13 inches wide, and 6 inches thick, cut to the proper curve, and the joints are alternated like those of masonry, to ensure strength. Each rib carries a trussed frame,—the two outer ones of which constitute the sides of the bridge; the road-ways between are roofed over, and as the whole is planked externally, the bridge is an enclosed gallery, lighted by numerous windows on each side; a simple lodge, or portico, at each end, contributes to the architectural beauty of this singular and simple work, which is in no way inferior to its mechanical †.

There is another bridge over the same river, of a similar construction, but consisting of three arches, the centre one 195 feet in span, the others 151. It is equally elegant as an object, though not so imposing as the last.

IRON BRIDGES.

The superiority of the British iron-manufactory, and the facility with which *castings* of the largest size are made in that metal, would naturally cause that material to be used in the construction of bridges, in situations where stone

* The reason for this is not apparent, as there was ample waterway, and therefore little force against the stone pier, which was the only part exposed to it; while it must have weakened the strength of the framing considered as a whole.

† The reader will find a view, and descriptive details, in Sir Howard Douglas's work on military bridges; a work to which we again are happy to allude for its great interest, even to those who, like ourselves, cannot presume to judge of its professional merits.

could not be employed, for the same reason that timber would be had recourse to in well-wooded countries under similar circumstances.

The bridge over the Severn, at Colebrookdale, in Shropshire, was the first iron bridge ever constructed; it was cast by Abraham Darley, at the great iron-works there, in 1777. The chord is 100 feet, and the arch nearly a semicircle; the abutments were unfortunately erected in a loose soil, and by yielding, they caused an injury to the work which required extensive reparation; but though in constant use, the bridge is now as efficient as ever. The expense of the whole was about 6000*l.*

The next iron bridge was as great an improvement on the first in principle, as it was superior to it in magnitude, and yet in both respects it has been since far surpassed; that we allude to is over the Wear, at Bishops' Wearmouth, near Sunderland. This elegant arch is 240 feet in span, with a versed sine of 30 feet, and the frame-work at the vertex is only 5 feet in depth. It is elevated 100 feet above the water, so that vessels of 300 tons' burden can sail under it without striking their topsails. The abutments are beautiful masses of rustic masonry, and the effect of the whole bridge is equally imposing and graceful.

Mr. Telford, in the same year, 1796, erected an iron bridge at Buildwas, in Shropshire, which is remarkable as consisting of two arches, one partly sustaining and partly suspending the other; the roadway is laid on three ribs, or arcs, of 130 feet in span, and 16 feet rise. On each side of the bridge is another arch, springing from a lower level of the abutments, but rising above the outer two ribs to the top of the parapet, and, therefore, cutting or crossing those ribs in two points, the part of the roadway-rib lying between these, is partly suspended from the upper arc, and the two segments beyond the same points is supported by the portion of the arc below, though, at the same time, the three flatter arcs form perfect arches in themselves, and could support themselves without the additional segments*. This bridge has perfectly answered the expectations of all concerned in it, and the whole expense did not much exceed 6000*l.*

The bridge over the Thames at Vauxhall was originally intended to be a stone one; there are, consequently, nine openings, each 80 feet wide, which is a much less span than was at all necessary for an iron bridge; the effect, however, is pleasing as a whole, though it wants the lightness of an iron arch of great span.

The finest bridge of metal, perhaps, in the world, is that at the end of Queen-street over the Thames, usually called the Southwark Bridge; it consists of three arches only, the centre one being 240 feet in span, with a versed sine of only 24, or one-tenth of the chord, while that at Sunderland is one-eighth of the same length; the frame-work in the former is, however, six feet in depth. This was also the work of Mr. Rennie, who thus had the honour of being the architect of three matchless structures in the greatest metropolis in the world.

When the plan of the new London Bridge was in contemplation, Mr. Telford designed an iron bridge for the site, in *one* span of *six hundred feet!* with a rise of 65, and a depth of 6 feet only at the crown. That such a man could have accomplished anything he proposed, there is no doubt; we should have been glad if the suggestion had been adopted, even though we should have lost the present bridge by it.

The *Pont des Arts*, at Paris, is an elegant iron bridge of nine arches, the total length being 505 feet; it was constructed by MM. Assart and Dillon; it is used only by foot passengers.

The *Pont d'Austerlitz*, or *Pont du Jardin des Plantes*, is another iron bridge adorning the same metropolis, and is an elegant structure of five semi-elliptic arches; it was built in 1802-5, from designs by Bapré.

This paper would be incomplete without some notice of Floating Bridges, or Bridges of Boats, which, though commonly only temporary works, to facilitate military operations in war, are yet adopted on some occasions as permanent bridges over rivers; this is the case at St. Petersburgh, Presburg, Coblentz, and other continental towns.

The general principle of these bridges consists in a roadway, supported by boats of a particular construction, anchored in a line across the stream. They are advantageously adopted on rivers with powerful currents, which, in winter-time, bring down large masses of ice, which would endanger the piers of an ordinary bridge; on such occasions an opening in the floating bridge is formed by unmooring a few boats and removing the roadway, or else the whole bridge is made to swing round with the current, and lie along the shore till the flood has subsided.

This power of cutting off the communication without injury to the bridge, is a recommendation which causes bridges of this kind to be used in frontier towns exposed to the attacks of an enemy.

Since any undulations in the river must affect the boats of a bridge, high winds cause a motion in the platform which is a drawback on their use, both as disagreeable and dangerous to passengers, and as straining the timber-work.

* This principle has been adopted by Mr. G. Leather, in the construction of an iron bridge over the Aire, near Leeds. The roadway is straight, and is entirely suspended by rods from, and partly carried, by iron arches of 152 feet span, and 43 feet rise from the chord-line; these two suspending arcs are placed one on each side of a central carriage-way, and the foot-paths are on the outside of them. This singular and novel work is a true combination of the arch and suspension bridges; it cost about 4200*l.* The same gentleman had previously, in 1827, constructed a bridge on the same plan over the same river.

SOUTHWARK BRIDGE.

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